

Claims:

- 1 1. An apparatus for determining at least one orientation
2 parameter of an elongate object having a tip contacting a
3 surface at a contact point, said apparatus comprising:
4 a) a projector on said elongate object for illuminating
5 said surface with a probe radiation in a predetermined
6 pattern from a first point of view;
7 b) a detector on said elongate object for detecting a
8 scattered portion of said probe radiation returning
9 from said surface to a second point of view;
10 c) a unit for determining said at least one orientation
11 parameter from a difference between said probe
12 radiation and said scattered portion.
13
1 2. The apparatus of claim 1, wherein said at least one
2 orientation parameter comprises an inclination angle θ
3 between an axis of said elongate object and a normal
4 to said surface at said contact point.
5
1 3. The apparatus of claim 2, wherein said at least
2 one orientation parameter further comprises a roll
3 angle ψ around said axis.
4
1 4. The apparatus of claim 1, wherein said surface
2 comprises a plane surface.
3
1 5. The apparatus of claim 1, wherein said predetermined
2 pattern comprises an asymmetric pattern.
3

- 1 6. The apparatus of claim 5, wherein said asymmetric
2 pattern is selected from the group consisting of
3 line sets, ellipses, rectangles and polygons.
4
- 1 7. The apparatus of claim 1, wherein said projector
2 comprises a structured light optic for projecting said
3 probe radiation onto said plane surface in said
4 predetermined pattern.
5
- 1 8. The apparatus of claim 7, wherein said structured
2 light optic comprises at least one element
3 selected from the group consisting of holographic
4 elements, diffractive elements, refractive
5 elements and reflective elements.
6
- 1 9. The apparatus of claim 1, wherein said elongated
2 object is selected from the group consisting of
3 jotting implements, pointers, robotic arms and canes.
4
- 1 10. The apparatus of claim 9, wherein said jotting
2 implements are selected from the group consisting
3 of pens, pencils and styluses.
4
- 1 11. An apparatus for determining at least one orientation
2 parameter of an elongate object having a tip contacting a
3 plane surface, and a normal to said plane surface, said
4 apparatus comprising:

- 5 a) a projector on said elongate object for illuminating
6 said plane surface with a probe radiation at an angle
7 σ to said axis;
- 8 b) a detector on said elongate object offset from said
9 projector for detecting a scattered portion of said
10 probe radiation returning from said plane surface at a
11 predetermined scatter angle τ to said axis;
- 12 c) a timing unit for deriving said at least one
13 orientation parameter from a detection time of said
14 scattered portion.

15

1 12. The apparatus of claim 11, wherein said at least one
2 orientation parameter comprises an inclination angle θ
3 between an axis of said elongate object and a normal
4 to said surface at said contact point.

5

1 13. The apparatus of claim 12, wherein said at least
2 one orientation parameter further comprises a roll
3 angle ψ around said axis.

4

1 14. The apparatus of claim 11, further comprising a
2 scanning arrangement for varying said angle σ in a
3 scan pattern.

4

1 15. The apparatus of claim 14, wherein said scanning
2 arrangement comprises a uniaxial scanner for
3 varying said angle σ by introducing an x-
4 deflection γ_x .

5

- 1 16. The apparatus of claim 14, wherein said scanning
2 arrangement comprises a biaxial scanner for
3 varying said angle σ by introducing an x-
4 deflection γ_x and a y-deflection γ_y .
5
- 1 17. The apparatus of claim 14, wherein said scanning
2 arrangement comprises a biaxial scanner for
3 varying said angle σ and said scan pattern is
4 selected from the group consisting of raster scan
5 patterns, line scan patterns and Lissajous
6 figures.
7
- 1 18. The apparatus of claim 11, wherein said projector
2 comprises a structured light optic for projecting said
3 probe radiation onto said plane surface in a
4 predetermined pattern.
5
- 1 19. The apparatus of claim 18, wherein said structured
2 light optic comprises at least one element
3 selected from the group consisting of holographic
4 elements, diffractive elements, refractive
5 elements and reflective elements.
6
- 1 20. The apparatus of claim 18, wherein said
2 predetermined pattern is selected from the group
3 consisting of line sets, ellipses, rectangles and
4 polygons.
5

1 21. The apparatus of claim 11, wherein said projector is
2 mounted above said detector.

3

1 22. The apparatus of claim 11, wherein said detector
2 further comprises a narrow field angle reception unit
3 for admitting to said detector only said scattered
4 portion returning from said plane surface at said
5 predetermined scatter angle τ .

6

1 23. The apparatus of claim 22, wherein said narrow
2 field angle reception unit is selected from the
3 group consisting of a cylindrical lens, a
4 collimating lens, a thick aperture, a system of
5 apertures, and a slit.

6

1 24. The apparatus of claim 11, wherein said detector
2 comprises a photodetector array.

3

1 25. The apparatus of claim 24, further comprising a
2 centroid computation unit for determining a
3 centroid of said scattered portion.

4

1 26. The apparatus of claim 11, further comprising an optic
2 for shaping said probe radiation into a scan beam.

3

1 27. The apparatus of claim 11, wherein said elongated
2 object is selected from the group consisting of
3 jotting implements, pointers, robotic arms and canes.

4

1 28. The apparatus of claim 27, wherein said jotting
2 implements are selected from the group consisting
3 of pens, pencils and styluses.
4

1 29. The apparatus of claim 11, wherein said timing unit is
2 located on said elongate object.
3

1 30. The apparatus of claim 11, wherein said projector
2 comprises a single frequency emitter for emitting said
3 probe radiation at a single frequency f .
4

1 31. A method for determining at least one orientation
2 parameter of an elongate object having a tip contacting a
3 surface at a contact point, said method comprising:
4 a) illuminating said surface with a probe radiation in a
5 predetermined pattern from a first point of view on
6 said elongate object;
7 b) detecting a scattered portion of said probe radiation
8 returning from said surface at a second point of view
9 on said elongate object;
10 c) determining said at least one orientation parameter
11 from a difference between said probe radiation and
12 said scattered portion.
13

1 32. The method of claim 31, wherein said predetermined
2 pattern is a scan pattern.
3

1 33. The method of claim 31, wherein said predetermined
2 pattern comprises an asymmetric pattern.

3

1 34. The method of claim 31, wherein said at least one
2 orientation parameter comprises at least one Euler
3 angle.

4

1 35. A method for determining an inclination angle θ between an
2 axis of an elongate object having a tip contacting a
3 plane surface, and a normal to said plane surface, said
4 method comprising:

- 5 a) providing a projector on said elongate object;
- 6 b) providing a detector on said elongate object, said
7 detector being offset from said projector;
- 8 c) illuminating said plane surface with a probe radiation
9 at an angle σ to said axis from said projector;
- 10 d) detecting a scattered portion of said probe radiation
11 returning from said plane surface at a predetermined
12 scatter angle τ to said axis with said detector;
- 13 e) a timing unit for deriving said inclination angle θ
14 from a detection time of said scattered portion.

15

1 36. The method of claim 35, wherein said angle σ is varied
2 in a scan pattern.

3

1 37. The method of claim 36, wherein said scan pattern
2 is selected from the group of uniaxial scan
3 patterns and biaxial scan patterns.

4